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NATURAL FIBERS IN NONWOVEN MANUFACTURE

ECONOMIC RESEARCH SERVICE
U.S. DEPARTMENT OF AGRICULTURE

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SUMMARY

Use of manmade fibers has weakened the competitive position of natural fibers in conventional textile production. As a result, cotton producers have an important stake in development of new sources of demand for natural fibers.

Since the introduction of nonwovens in the thirties, and especially in the postwar era, the market for bonded fiber fabrics has increased rapidly. The new processes have brought increased efficiency in fabric manufacture by eliminating expensive spinning and weaving.

Development of nonwoven fabrication has opened a new market for great quantities of raw materials. If cotton captures a significant share of this market it has a potential for large growth in future sales.

Nonwoven fabric production, defined broadly for this study (see p. 1), exceeded 1 billion pounds in 1967. Bonded fiber fabrics made up 9.4 percent of this total; felts and punched and needled materials, 30.3 percent; and padding materials, 60.3 percent. During the last decade, bonded fiber fabrics generated most of the enthusiasm about the dynamic and exciting potential of the nonwoven industry.

Bonded fiber fabrics--a 150-million-pound market for fiber--displayed a 10.6 percent average annual growth rate from 1961 to 1967. Cotton's share of total fibers used was four-tenths in 1958, one-fourth in 1961, and less than one-tenth in 1967. The initial development of bonded fiber materials was an effort to increase the use of cotton waste and low-quality cotton. Rayon supplanted cotton in a large share of the market during the 1950's, and other manmade fibers have strongly encroached on both rayon and cotton during the 1960's.

Cotton is a potential competitor for about three-fourths of the market for fibers used in bonded fiber fabrics. It competes mainly with rayon. Its main disadvantages are high cleaning costs and lack of uniformity. Thus, cotton's price relative to rayon must be low enough to overcome these shortcomings if cotton is to regain sales. Cotton has some favorable natural properties and has the potential to regain some of its past loss of the market if it can to improve processing performance and price competitiveness.

Padding materials--a 600-million-pound market--have displayed a 1 percent annual growth rate. These materials go into bedding (46 percent), automotive padding (29 percent), and furniture (25 percent). Cotton's two-thirds of the total padding market includes 86 percent of the bedding, 63 percent of the automotive, and 24 percent of the furniture padding markets. The bedding, automotive, and furniture markets have good growth potentials. Although cotton has lost ground to foam rubber and polyurethane foam in each of these markets,

recent research developments have increased cotton's potential for maintaining and expanding its share of the padding market.

Felts--a 340-million-pound fiber market--represent one-third of nonwoven production and have displayed a 2-percent annual growth rate. About 10 percent of fibers used are wool. A relatively small amount of cotton is used. Hair, jute, and hair and jute laminated with sponge rubber or foam are the predominant raw materials used in felt. The primary uses of punched and needled felts are for linings and pads for both carpets and rugs. There seems to be little opportunity for growth in the use of natural fibers in this market. There has been a rapid growth in the use of synthetic rubber.

NATURAL FIBERS IN NONWOVEN MANUFACTURE

by C. A. Moore and O. C. Hester [1/]

INTRODUCTION

The textile industry is continually changing. Shifts in geographic location and modification of the industry's structure have been in process for more than three decades. Technological innovations in fibers, processes, machinery, and products have become a major force in the competitive struggle among firms within the industry. Improved materials handling, faster processing, and automated control have been introduced at a rapid pace. Characteristics of new synthetic fibers permit higher speed in spinning and weaving than is possible with natural fibers.

Searching for increased efficiency to offset increasing costs of labor and equipment, the industry has directed much effort toward eliminating some or all of the expensive conventional steps of parallelizing and spinning fibers then weaving them into fabric. Plastic film or sheets, while displacing large quantities of woven and coated fabrics, lack the characteristics desired in many uses. Numerous methods of fabric forming have been explored.

Few of these developments have received more attention or created more expectations than have nonwovens. The advent and growth of manmade fibers have made serious inroads on natural fibers in conventional textile production. Consequently, the development of nonwoven fabrication raises questions about its effect on the future use of natural fibers.

This study evaluates the use of natural fibers in nonwoven manufacture to (1) provide cotton producers and fiber processing industries with a current assessment of the situation and (2) assist the utilization laboratories of the Department in orienting their research programs so that agricultural materials can compete more successfully in this expanding market.

The term "nonwovens" was initiated, established, and still is used as a trade concept. Application of the term varies widely among different writers. Indeed, the nonwoven industry has been dubbed "the booming misnomer." (2, p. 50). [2/]

There are some consistencies in usage, however. For example, fabrications from spun yarn (such as knitted, braided, laced, and embroidered, as

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1/ Economic Research Service and Consumer and Marketing Service, U.S. Dept. Agr., respectively.

2/ Underscored numbers in parentheses refer to Literature Cited, as listed at the end of this report, page 17.

well as woven, goods) are generally excluded. Nonwoven fabrics could aptly be termed "nonspun." They are constructed directly from the fiber rather than from a yarn constructed from the fiber.

The trade consistently includes bonded fiber fabrics in nonwovens. A bonded fiber fabric is defined as "a web or mat of fibers held together with a bonding material." 3/ The bonding agent may be an adhesive compound added to the fiber mat, or the fiber mat may contain thermoplastic fibers which fuse with the other fibers by heat treatment.

Mechanically bonded fabrics are made by a web or mat of fibers held together by fiber entanglement. Some textile people exclude from nonwovens some or all of such materials (15, p. 1; 16, p. 44; 19, p. 60) while others include them (1, p. 13; 7, p. 50; 10, p. 54; 20, p. 2). Inclusion of mechanically bonded materials affects (1) the size and structure of the nonwoven industry, (2) the size and character of the market for natural fibers in nonwoven manufacture, and (3) the level and growth of nonwoven production.

A minimum content of binder materials, such as 5 percent of finished fabric weight (15, p. 1), may be specified in defining "nonwovens." This is done to exclude materials constructed mainly by fiber entanglement but containing a small amount of adhesive material. Also, nonwovens are sometimes defined by the minimum length of fibers used in their construction, such as .75 inches (14, p. 25). This minimum excludes some materials made by the wet-process method with modified papermaking techniques and differentiates "fabric" from "paper."

The term "nonwovens" is used here in the broadest sense to include bonded fiber fabrics, conventional felts, and padding materials. Most writers exclude padding materials from nonwovens. These materials are included here solely because of their importance as a natural fiber market--not because of any definitional preference.

Nonwovens in this broad sense is a web or mat of fibers held together by a bonding material, a bonding process, or a combination of material and process. Felting, needle-punching, pressing, solution-wetting, or similar means of promoting fiber entanglement are considered bonding processes.

DEVELOPMENT AND STRUCTURE OF NONWOVENS

Nonwovens are usually discussed as a recent development. Yet, while bonded fiber fabrics and some "needle-punched" materials can be so considered, some felts and battings cannot.

3/ Definition by the American Society for Testing Materials (ASTM). Further confusion results from the tendency of some writers to use the term "bonded fabrics" in reference to bonded fiber fabrics. "Bonded fabrics" generally include materials constructed by bonding or laminating two or more fabrics which may be woven, knitted, or bonded fiber, or a combination of these.

Cotton textile mills seeking an outlet for "waste" cotton during the 1930's were responsible for developing bonded fiber fabrics (15, p. 1). Only a few thousand pounds were being produced annually by the end of World War II (5, p. 4). But, by the late 1940's the growth potential for these fabrics was recognized, and research and development efforts were intensified (13, p. 1081). The appearance in the early 1950's of a relatively expensive bonded fiber fabric made from a mixture of rayon, cotton, and nylon for use in interlinings proved to be a benchmark for progress (5, p. 4; 19, p. 61). When this fabric established itself in the market, it proved that more expensive bonded fiber materials could find sales outlets if they satisfied consumer wants. Thus, bonded fiber fabrics gained wide market acceptance by the mid-1950's. Since then, successes in research and development have led to further growth.

Unlike the production of bonded fiber fabrics, felting is an ancient process. Felt probably represents the first type of fabric made by man (5, p. 1). The traditional felting process involves random dispersion and oscillation of moistened wool fibers on a screen. This process facilitates shrinking, curling, and interlocking of the scaly-surfaced wool fibers as they come into contact.

Traditional wool felting represents only a small part of modern day felting. 4/ Use of caustic soda in felting cotton fibers, needle-punching, and other techniques have broadened the applications of felting, enlarging the number of fibers that can be used in fabric construction by entanglement. Thus, felting includes some modern developments, such as needle-punching, which are the focus of "innovation" interest by the textile industry. Needle-punched materials have demonstrated growth potential on a par with that of the bonded fiber fabrics (5, p. 40; 8, p. 29).

Cotton Flote was developed as a cooperative research venture jointly supported by industry and the USDA Southern Regional Research Laboratory. The new material exemplifies the combination of fiber entanglement and bonding of fibers to produce a cotton product with good potential in automotive padding and furniture upholstery use. This potential will be discussed later.

NONWOVEN PRODUCTION

Data on the size of the nonwoven industry vary widely in textile literature. This variance is mainly due to differences among definitions although it is partly a consequence of the industry's reluctance to release information on its materials and processes. This study relied mostly on data reported by the Bureau of the Census, U.S. Department of Commerce.

Total production of nonwovens 5/ in 1963 amounted to about 1,012 million pounds (table 1). Bonded fiber fabrics contributed slightly less than 10 percent of the total; felts and needle-punched materials, 30 percent; and padding materials, 60 percent.

4/ Felting as used here includes fabrics constructed by controlled fiber entanglement.

5/ As applied to data selected for table 1.

Table 1.--Nonwovens production, 1963, and annual rates of increase, 1958-65, by type of goods and market outlet

Item	Production (1963)		Annual rate of increase
	Amount	Percentage of total	
	1,000 lb.	Percent	Percent
Bonded fiber fabrics	95,475	9.4	1/10.6
Felts and punched and needled materials:			
Pressed wool felts	18,641		
Punched or needled felts, except carpet, rug linings, and cushions	74,795		
Punched or needled carpet, rug linings and cushions 2/	213,140		
Total	306,576	30.3	2.1
Padding materials:			
Automotive and other padding of hard fibers	250,691		
Batting, wadding and mattress felts	267,191		
Upholstery filling and others	92,026		
Total	609,908	60.3	1.2
Total nonwovens	1,011,959	100.0	

1/ 1961 through 1967. 1961 data were adjusted (increased) to compensate for firms not reporting which had tended to lower the rate.
2/ Based on 32 ounces per square yard.

Source: Current Indust. Rpts. Nonwoven Fabrics, Series M22T5, Bur. of Census, U.S. Dept. Commerce. 1963 Census of Manufacturers, 22F Textile Mill Products, based on shipments which included interplant transfers.

Table 1 shows why estimates of nonwoven production vary so widely. If nonwovens are defined as including only bonded fiber fabrics, 1963 production amounted to about 95 million pounds, according to Department of Commerce estimates. If pressed wool felts and punched and needled felts--except carpet and rug linings and cushions--are added (the first and second items under "felts and punched and needled materials" in table 1), the 1963 production was about 189 million pounds. Most estimates in trade publications vary between these two categories with few experts willing to include padding and rug materials among nonwovens 6/ as this study does. The 92 million pounds of upholstery filling is included by our liberal definition because of its similarity to automotive padding and interlinings.

6/ A few, however, insist they be included. See reference 1, p. 13; 10, p. 54; 11, p. 78.

Current production of bonded fiber fabrics probably exceeds 200 million pounds annually based on an annual increase in production of 10.6 percent (table 1). This is most likely a conservative estimate as some estimates have put annual increases nearer 20 percent in recent years.

Other categories of nonwovens have displayed only moderate growth. Pressed wool felts and punched or needled materials in the carpet and rug trade have little growth potential. Their share of the market is threatened by foam rubber padding and cushions. However, the market potential seems promising for newer processes and for applications of needle and punched materials in other than floor coverings.

BONDED FIBER FABRICS

The fast-growing production and acceptance of bonded fiber fabrics are the center of interest--some insist the whole content--of the nonwoven industry. The first ones on the market were almost exclusively of cotton, other than the bonding agent (17, p. 2). Rayon, which appeared quite early, became cotton's chief competitor. Because of rayon's relatively low cost, ease of manufacture, and quality characteristics, use of rayon grew substantially during the 1950's while use of cotton declined.

More recently, greater use of manmade fibers and increased blending of fibers are significant developments in bonded fiber materials. These developments result from some redirection in ways of thinking about nonwovens. Initial emphasis was on utilization of waste cotton; a "disposable-after-one-use" product at a market price competitive with the cost of the "one-time-use" cloth product it replaced; and penetration of a limited number of specialized, low-cost product markets. The developing demand for bonded fiber fabrics revealed a broader horizon. An awareness grew that bonded fiber fabrics had potentials and competitive strength of their own. The potentials involved a wide variety of end products for different uses. In general, greater durability, better appearance, and increased convenience in use characterized the product developments of nonwoven manufacturers in the late 1950's and early 1960's.

The various qualities desired in the many end products require special qualities in the raw materials used--the binders and fibers. Use of higher priced manmade fibers and synthetic resin binders, at a cost prohibitive for the cheaper "throwaway" products aimed for earlier, became economically feasible in producing more durable bonded fiber fabrics to compete in higher priced markets.

Bonded fiber fabrics generally are composed of 15- to 50-percent bonding agents and 50- to 85-percent fiber. An estimate of 30-percent binder content has been used as an average for total production (16, p. 44). This proportion may have declined in recent years as improved binder materials have become available and processing techniques have been improved.

Characteristics of the end product are determined by the kind of binder, kind of fiber, ratio of fiber blend (if more than one fiber is used), ratio of

binder to fiber in the finished material, and the process used in manufacture. There is a wide range of possible combinations of these variables, which gives good potential for products tailormade for specific uses. Moreover, because of the dynamic nature of the industry, the fund of technological "know-how" is increasing rapidly.

Binder materials used in bonded fiber fabrics in 1968 probably amounted to 50 to 75 million pounds, dry weight. Market growth exceeding 15 percent in some years has been sufficient to excite the interest of binder manufacturers.

Starch was the first binder used in bonded fiber fabrics (13, p. 1081). It is the lowest cost binder and is easily applied but is nonpermanent and gives a stiff, brittle product. Starch's low price gives it a competitive advantage in products where the properties it imparts do not hinder its sale and use. These products are presently confined to low-cost fabrics and use as a preliminary binder to hold the web structure together during processing (15, p. 7).

Manufacturers of bonded fiber fabric are reticent about revealing the kinds and amounts of bonding agents used in their end products. Apparently, most bonding involves combining binders in rather complex systems (18, p. 6). No estimates of starch use as a binder are available. However, its use probably amounts to less than 5 million pounds annually.

Synthetic resins have a major share of the binder market. The development of synthetic resins with improved performance was an important contribution to industry growth. A small amount of natural gums and casein are also used as a binder in some cases.

Various acrylic materials are reported to be increasing in use as binders. Before the introduction of acrylics, polyvinyl acetate was most popular, and large quantities are still used. Butadiene-acrylonitrile and other latexes are also used. The price of binding materials ranges from 30 to 50 cents a pound, and that of starch from about 5 to 7 cents a pound. However, binder materials are selected and binding systems formulated to impart the properties desired in the end product. Although the desired properties vary among products,they include high strength, ease of uniform application to web, high specific adhesion to fiber, good elasticity and elastic recovery, and--depending on application--light-fastness, clean-fastness, wash-fastness, freedom from discoloration, and good dimensional stability (19, p. 62).

The fibers used in bonded fiber fabric production for 1958 were approximately as follows: cotton, 41 percent; rayon, 36 percent; acetate, 12 percent; and other fiber, 11 percent (5, p. 48). "Primarily cotton" fabrics declined from 26.8 percent (20.8 million pounds) in 1961 to 9.1 percent (13.0 million pounds) in 1967 (table 2). Rayon declined as a proportion of the total during the same period, even though "primarily rayon" fabrics increased from 41 to 56 million pounds. "Primarily other fiber" fabrics increasedfrom 16 to 74 million pounds, enlarging their share of the rapidly expanding market from one-fifth to over one-half in 5 years.

Table 2.--Bonded fiber fabric production and annual rates of increase, 1961-67

Item	Production							Annual rate of increase, 1961-67
	1961 1/	1962 1/	1963	1964	1965	1966	1967	
	1,000 lb.							Percent
Bonded fiber fabrics	77,598	86,830	95,475	111,194	128,916	133,613	142,218	10.6
Primarily rayon	40,972	42,412	44,042	52,182	60,147	54,035	55,525	5.2
Primarily cotton	20,796	17,844	17,807	13,014	12,166	11,925	13,007	- 7.5
Primarily other fiber	15,830	26,574	33,626	45,998	56,603	67,653	73,686	29.2
	Percent							
Primarily rayon	52.8	48.8	46.1	46.9	46.7	40.5	39.1	--
Primarily cotton	26.8	20.6	18.7	11.7	9.4	8.9	9.1	--
Primarily other fiber	20.4	30.6	35.2	41.4	43.9	50.6	51.8	--

1/ Bur. of Census data for 1962 were assumed to cover only 82 percent of total production (and were increased accordingly). Reported production for 1961 was increased by 22.8 percent, and 1962 data were revised upward by 19 percent. Adjustments were based on Census acknowledgement of unreported data.

Source: Bur. of Census, Bonded Fiber Fabrics (Nonwoven Textiles), Current Indust. Rpts., Series M22T.5.

Volumes reported by the Bureau of Census (table 2) were 20 to 50 percent less than estimates by industry sources, due in part to differences in definitions (3, p. 92). Shearer estimated (16, p. 44; 18) 102 million pounds of fibers were consumed by the industry in 1960, and 123 million in 1962. Estimates for 1966 range from 170 million (6, p. 100) to over 200 million pounds (9, p. 60). 7/

Most bonded fiber fabrics made today are a blend of fibers, often as many as three or more in a fabric (4, p. 648). Fibers are blended to obtain properties desired in the end product by combining properties of the various fibers. By this process, some inexpensive natural fiber material may be used in products that require properties of more expensive manmade fibers. Consequently, greater amounts of cotton may be used in today's bonded fiber fabrics than are indicated in table 2.

Table 3 indicates the bonded fiber fabric categories where cotton is used and its principal competitors in each category. Competition is almost exclusively with rayon and acetate. Cotton is used in bonded fiber products made for the disposable industrial, household, sanitary, and medical markets--relatively large categories in the early 1960's, and considered the fastest growing markets for disposables today. Cotton has desirable properties for products in the hospital market, such as absorbent pads, personal items, and towels. Cotton is also good for desiccant bags, filters, gaskets, packaging waddings, wiping cloths, apparel patterns, disposable towels, and casket paddings. Cotton's disadvantages include high cleaning costs before use, lack of uniform length, and relatively low strength, but it provides a soft, flexible, relatively bulky hand and usually a highly absorbent end product (19, p. 61).

Estimates by Shearer (table 3) indicate that cotton is a potential raw material competitor in about three-fourths of the total bonded fiber fabric market, and that its price relative to the price of rayon usually determines which is used. Rayon usually costs only slightly more than comber waste, is easier to process, and has greater strength of product because of longer fiber. Otherwise, the two fibers have many similar qualities.

Both cotton and rayon have lost ground recently to new manmade fibers on the basis of qualities of the latter such as greater resistance to chemicals, lower absorbency, more resistance to wear, and lower density. Manmade fibers are gaining a larger share of the total market, even though their price is as much as five times that of cotton and rayon (5, p. 47).

Despite the downtrend in cotton use in bonded fiber fabrics, the total end product market is sizable and has displayed rapid growth. For these reasons, its potential as a market for cotton should not be ignored. New technology and innovations are being developed to take advantage of cotton's properties and price. Research to improve the properties of products made from cotton for this market could pay large dividends on the investment.

7/ Harvey's estimate of production was "some 300 million pounds" (9, p. 60). Assuming fibers average 70 percent of the weight, the estimate would involve 210 million pounds of fibers.

Table 3.--Estimated consumption of fibers in selected nonwoven fabric markets, 1960 and 1962

Category of use	1960	1962	Principal fibers
	Mil. lb.	Mil. lb.	
Abrasives (coated discs, pads, fabric, etc.)	1	3	Nylon, rayon
Apparel (interlinings, inner- and outer-wear, etc.)	12	14	Rayon, nylon, acetate
Coated fabrics (automotive, furniture, wall covering, shoes, rug backing, tentage, etc.)	12	12	Cotton, rayon, acetate
Filters (milk, chemical, air, oil, etc.)	10	14	Rayon, glass, acetate
Laminated plastics (overlay sheets, electronic quilting, high and low pressure)	3	3	Rayon, cotton, glass, acrylic
Sanitary and medical (hospital and doctor supplies, diapers, bandages, face masks, etc.)	30	35	Rayon, cotton
Tapes and ribbons (decorative and industrial)	19	21	Cotton, rayon, acetate, dacron
Wiping cloths (dust, shining, polishing, mopping)	6	8	Cotton, rayon
Miscellaneous household (towels, napkins, drapes, shades, etc.)	6	8	Rayon, cotton, acetate
Miscellaneous small items (casket linings, hair waving, book binding, headers, etc.)	3	5	All types
Total	102	123	

Source: Shearer, Howard E., "Fibers Used in the Production of Nonwoven Fabrics," American Dyestuff Reporter, Aug. 20, 1962, p. 44, for 1962 data, and "Status of Nonwoven Fabrics in the Textile Trade," American Dyestuff Reporter, Apr. 17, 1961, for 1960 data.

PADDING MATERIALS

Automotive padding accounted for about 35 percent of the 610 million pounds of padding and upholstery materials produced in 1963 (table 1). The Census data were not reported by end use and reflected actual weight of quantities used. However, the newer synthetic materials used in padding are of lower density; consequently, a given weight has greater volume and covers greater end-product area than conventional cotton paddings. In general, equivalent volumes of the different materials are required in each end product and a lighter material at a higher cost may be preferred for some end uses.

Cotton is the most important natural fiber used in the padding market. Considered the conventional padding material, it retains a major share of the auto and bedding markets. Since cotton will be the focus of our analysis, data on the use of padding materials in bedding, furniture, and automobiles will be reported here in cotton batting equivalent weights. 8/ Some wool and mohair are used in paddings but in relatively insignificant quantities. Animal hair also is used but has little economic importance.

Padding materials for bedding, motor vehicles, and furniture combined are almost a billion-pound market (in cotton batting equivalent weight, table 4).

Table 4.--Consumption of mattress felts, and padding and cushioning materials by type and use, 1965-67 annual average

Type of material	Unit	Padding material consumed by end use 1/			
		Bedding	Automotive	Furniture	Total
All materials	Mil. lb.	438.7	270.3	240.0	949.0
As percentage of total	Pct.	46.2	28.5	25.3	100.0
Cotton batting	Mil. lb.	375.7	169.0	57.7	602.4
As percentage of all materials	Pct.	85.6	62.5	24.0	63.5
Linters	Mil. lb.	219.3	93.7	33.0	346.0
As percentage of cotton batting	Pct.	58.4	55.4	57.2	57.4
Waste	Mil. lb.	156.4	75.3	24.7	256.4
As percentage of cotton batting	Pct.	41.6	44.6	42.8	42.6

1/ Weights are in cotton batting equivalents.

Source: Mktg. Res. Serv., Nat. Cotton Council of America.

8/ The weight of cotton required to make an equivalent product. Since foam (rubber and polyurethane) materials are the main competitors of cotton and are relatively light, the cotton equivalent weight is greater than the actual weight.

Bedding comprised 46 percent, automotive padding 29 percent, and furniture 25 percent of the market during 1965-67.

Cotton batting now has less than two-thirds of the total padding market. This proportion varies, however, with end use. Cotton accounts for 86 percent of all materials in bedding (in cotton batting equivalent weight), 63 percent in automotive padding, and only 26 percent in furniture. Thus, it retains the dominant share of the largest segment (bedding) of the padding market.

Fiber composition of cotton batting averages about 60 percent cotton linters and 40 percent cotton waste. The ratio is about the same in all three segments of the padding market.

Bedding

Bedding uses about 46 percent of all padding materials and more than three-fifths of the total cotton batting used in padding. While the size of the market is important, its growth rate has been low--about in line with population growth.

Mattress and bedspring production increased at an average annual rate of about 1 percent from 1957 to 1963 based on Census data. Shipments have recently shown a rapid increase (fig. 1). While mattress production was some

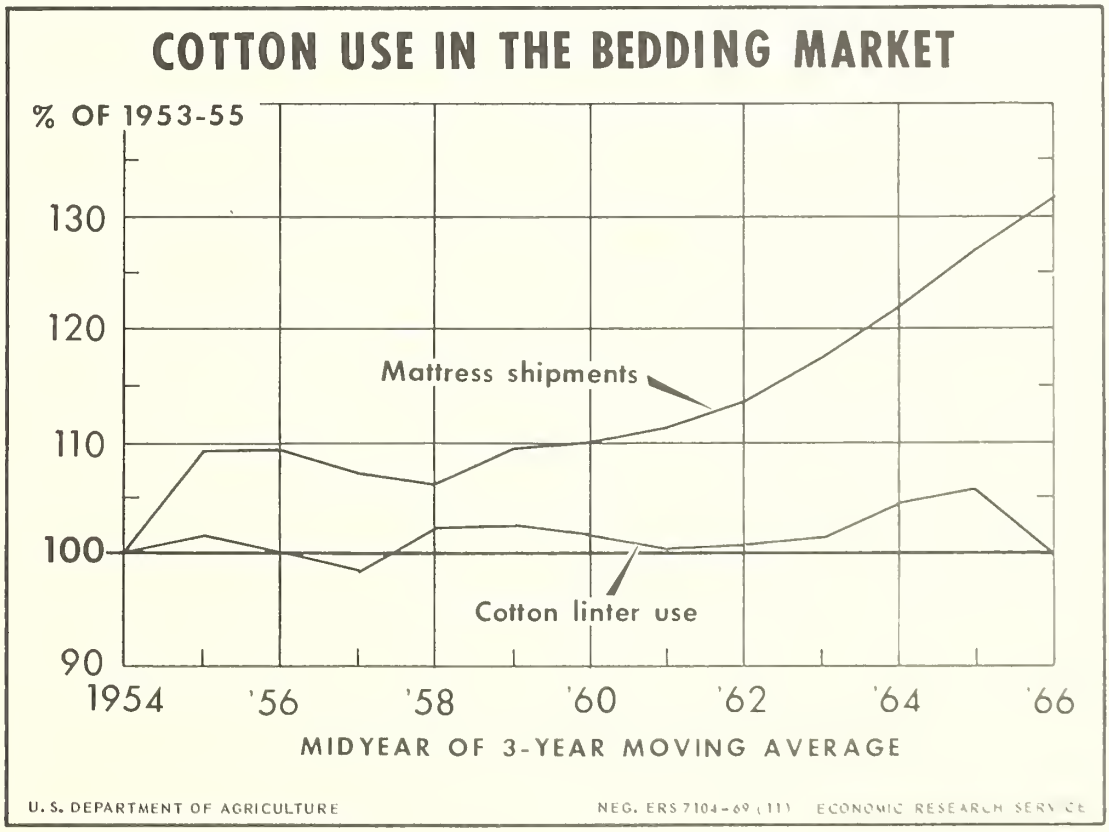

Figure 1

30 percent greater in 1965-67 than in 1953-55, cotton consumption (based on linters) in bedding was about the same. Foam replaced cotton in mattresses in sufficient quantities to fill the gap. Rubber mattress shipments were 6.6 percent of total shipments in 1953 and 5.1 percent in 1967. Polyurethane increased its share of total shipments from 1.6 percent in 1960 to 9.7 percent in 1967 and presently threatens both cotton and foam rubber.

Cotton still retained 86 percent of the bedding market in 1965-67. Moreover, the annual percentage was steady at that level during the 4 years ending in 1967. People prefer the properties of cotton that have not been duplicated by foam material. These properties include resilience at varying temperatures, absorptive capacity, resistance to discoloration, and compatibility with a wide variety of upholstery fabrics. Foam materials replaced cotton in about 14 percent of the market by cotton batting equivalent weight, but less than that in actual weight. It takes little more than half the amount (by weight) of polyurethane foam to produce the equivalent amount of conventional cotton batting.

Automotive Padding

Of the 270 million pounds of cotton equivalent padding materials used in automobiles annually during 1965-67, 169 million were of cotton. The widening margin between the index of cotton batting used and the index of automotive production indicates cotton's loss in that market since 1948-52 (fig. 2).

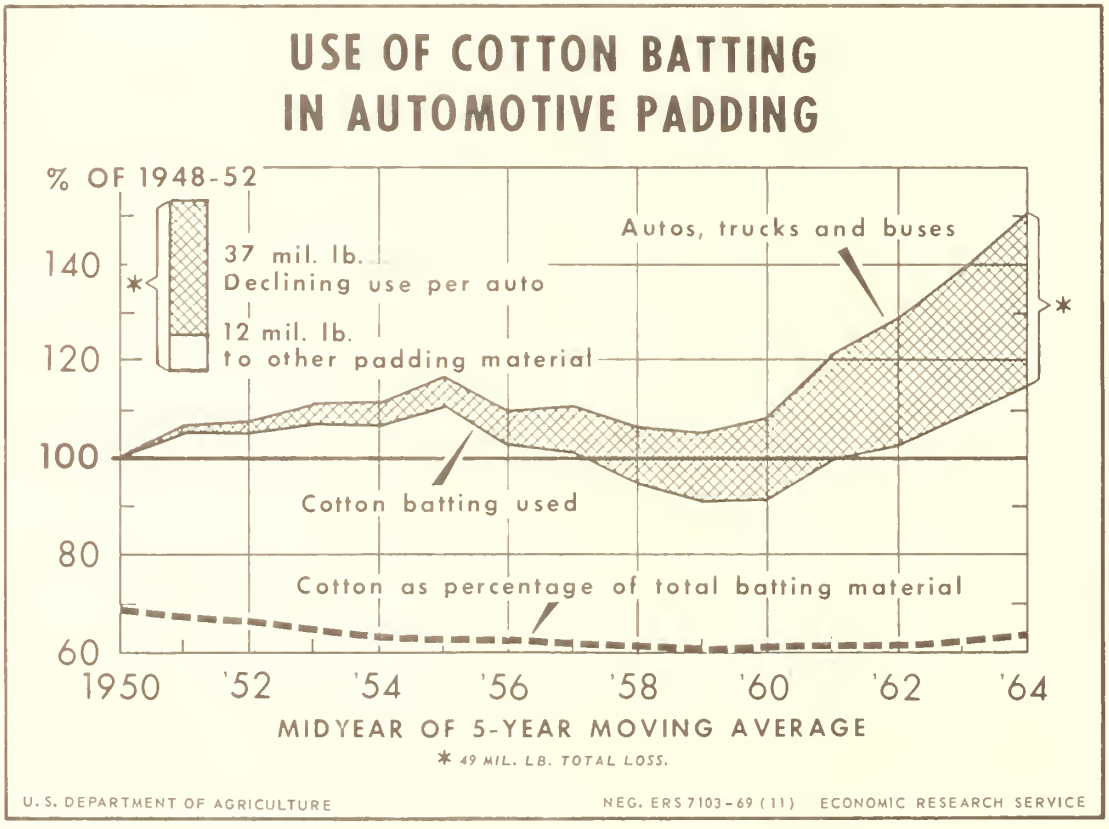

Figure 2

The loss has two roots. One is greater efficiency, either in padding material performance or in construction, resulting in less weight used (cotton equivalent weight) per automobile. Most of the loss has occurred since the mid-1950's and amounts to about 17 percent less material per car.

The second factor is cotton's loss to synthetic padding materials, depicted by the trend line in the lower part of figure 2. Cotton's percentage of total batting materials used in automobiles declined consistently (5-year moving average base) until the early 1960's. It has been recovering since. From 68.8 percent of total padding materials in 1948-52, it declined to a low of 59.8 percent in 1957-61. It recovered to 63.4 percent in 1962-66.

The recent recovery is due to the added competitive strength given cotton by the development of Cotton Flote and by improvements in other properties of cotton batting by industry and the Southern Regional Research Laboratory. A research program was initiated in 1961 to improve cotton batting by development of a textile structure with (1) better thickness retention, (2) more resilience, (3) improved cohesiveness and structural and dimensional stability, (4) less weight per volume, (5) moldability, (6) flame resistance, and (7) greater and more rapid recovery from loading deformation (12, p. 1). The development of Cotton Flote and additional improvements were primarily responsible for arresting the downtrend and recovering some of cotton's previous losses in the auto padding market.

Although the future for cotton batting in the automotive market is uncertain, there are some encouraging aspects. The recent upturn in cotton's percentage of total batting materials shows the industry still accepts cotton as a competitive material. It also attests to the fact that end products can be improved to display properties desired by the industry. The large and growing automobile market for padding is certainly one worth fighting for.

Furniture

Furniture uses one-fourth of all padding materials but less than one-tenth of all cotton batting consumed annually. The market consumes about 240 million pounds (cotton batting equivalent weight) of padding materials annually, but only one-fourth of this total is cotton.

Total cushioning materials in furniture (cotton batting equivalent weight) increased by 70 percent--from 141 million pounds annually in 1952-54 to 240 million pounds annually in 1965-67 (fig. 3). Use of cotton batting declined during the same period by 30 percent, from 82 to 58 million pounds. Had cotton batting retained the same share of the total furniture padding market it had in 1952-54, 139 million pounds would have been used annually during 1965-67. The loss was 81 million pounds.

The padding market in furniture is growing. From 1952-54 to 1965-67, total cushioning materials used in furniture increased 4.2 percent annually, almost three times the rate of population growth. The demand for cushioned furniture evidently has a high income elasticity. About one-third of the increase in padding material in furniture was attributable to the increase in

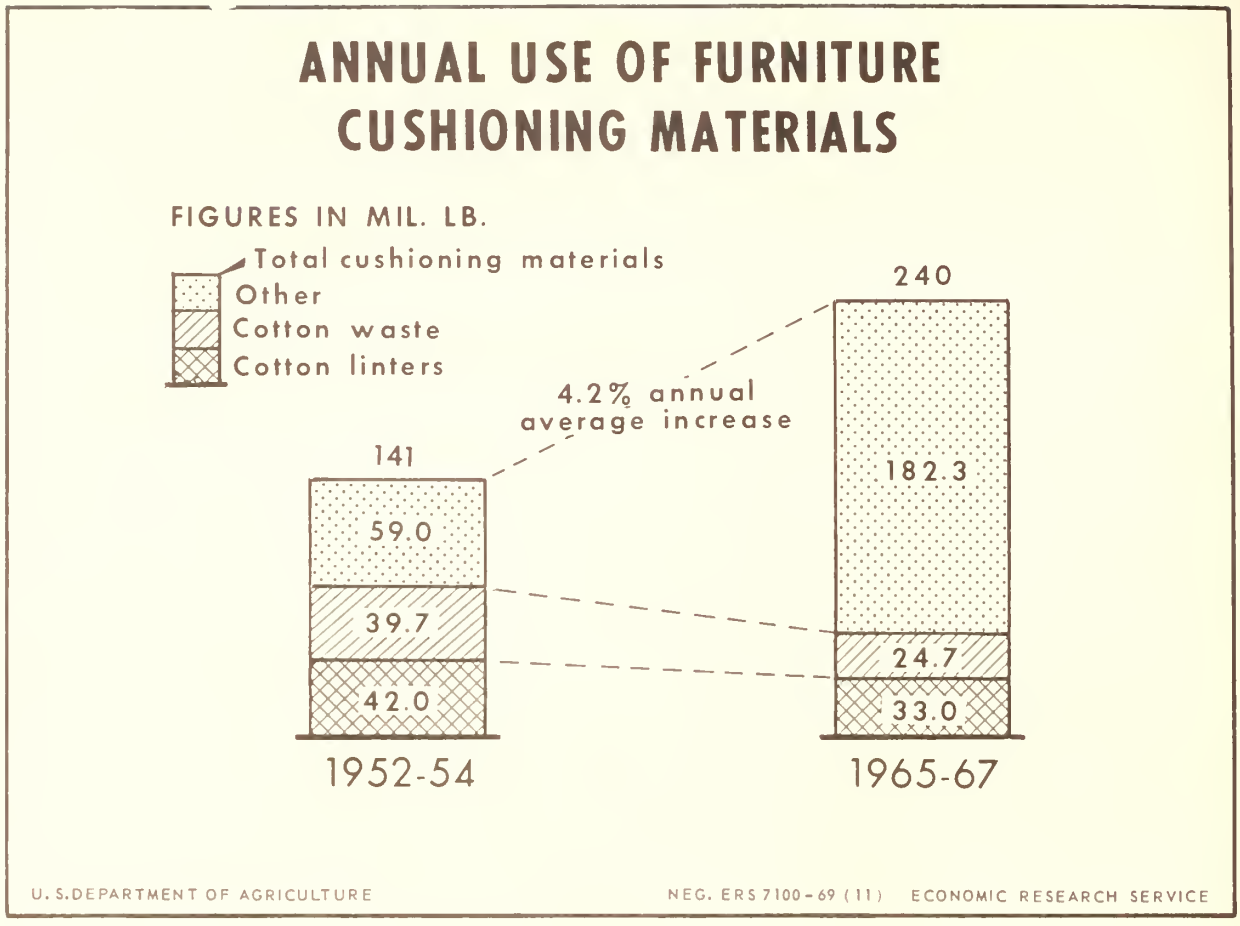

Figure 3

population, while two-thirds was due to increasing incomes and changing preferences. Thus, cotton has incurred considerable competitive loss in an expanding market.

In summary, cotton (linters and waste) lost a 149-million-pound segment of the annual padding market from the early 1950's to the mid-1960's. The loss is computed as the difference between the amount actually used in 1965-67 and that which would have been used at the rate that prevailed in 1952-54. 9/ The loss amounted to 19 million pounds in bedding, 49 million in automotive padding, and 81 million in furniture.

However, 37 of the 49-million-pound loss in the automobile industry was due to a declining use of padding materials per unit; that is, greater efficiency or more economy of padding in cars. Only 12 million pounds, 7 percent of annual sales, were lost to competing padding materials.

9/ From 1948-52 to 1962-66 for the automotive industry.

The data depict the relative competitive situation. Cotton's tremendous loss to synthetic padding materials in furniture has left it only one-fourth of that market. However, cotton is waging a strong battle to retain the automotive padding market. Recent trends are promising. The automotive padding market may be more susceptible to encroachment of synthetic foam materials than is the bedding market, but recent development of Cotton Flote gives cotton added strength in the auto market. And cotton's competitive position in bedding appears firm for at least the next 5 to 10 years.

FELT NONWOVENS

In 1963, felt goods included among nonwovens were in excess of 300 million pounds, about 30 percent of total nonwovens (table 1). Most of the market for felt nonwoven raw materials is taken by jute and hair.

Twenty million pounds of felt nonwovens were pressed wool felts in 1965 (table 5). An estimated 0.7 to 1.4 million pounds of wool were used in punched and needled felts for other than carpet and rug linings and cushions (third item, table 5). Thus, wool comprises less than 10 percent of all fibers used in the nonwoven felts. A small, relatively insignificant amount of cotton waste is used.

The punched and needled felts comprise over 90 percent of the nonwoven felts. Nonwoven felts are used primarily as linings and cushions for carpets and rugs and similar uses. Consequently, we can gain some insight into the competitive market situation for nonwoven felts over time by what has happened in carpet and rugs.

From 1958 to 1965, Broadloom carpet and rug production grew from 122.6 million square yards to 310.5 million, an annual rate of increase of 14.2 percent. In comparison, use of nonwoven punched or needled felts grew at an annual rate of 2.1 percent (table 5). Had use of nonwoven punched or needled felts in carpets and rugs increased at the same rate as carpet and rug production, 500 million pounds would have been produced in 1965, compared with the 228 million actually produced. The difference between these figures represents a sizable market loss to rubber backings and pads.

A favorable growth rate of 2.1 percent was attained by hair and jute linings and cushions from 1958 to 1965. However, this growth is threatened by the rapid encroachment of synthetic rubber backings. This very likely portends trouble for jute, hair, and wool in nonwoven felts. The animal hair used in this market could become a disposal problem to some supplying companies if the market is lost.

Table 5.--Felt nonwoven production, 1958 and 1963-65, and annual rate of increase 1958-65 1/

Item	Production				Annual rate of increase, 1958-65
	1958	1963	1964	1965	
	1,000 lb.				Percent
Pressed wool felts	17,579	18,641	18,893	20,414	2.1
Punched or needled felts:					
Carpet and rug linings, cushions 2/	197,438	213,140	224,862	227,948	2.1
Hair and jute	NR	(57,635)	(55,493)	(58,563)	
Hair and jute laminated with foam, sponge, etc.	NR	(48,935)	(56,938)	(55,411)	
Punched or needled felts:					
Except carpet and rug linings and cushions	70,991	74,795	74,992	82,603	2.2
Hair and jute felts	NR	(70,730)	(68,041)	(75,928)	
Wool felts and manmade fiber felts 3/	NR	(4,065)	(6,951)	(6,775)	
Total	286,008	306,576	318,747	330,965	2.1

NR = Not reported.
1/ Felts, except nonwoven felts and hats.
2/ Reported in square yards. Conversion rate 32 ounces per square yard.
3/ Wool felts account for 10-20 percent of total.

Source: 1963 Census of Manufacturers and Current Indust. Rpts., Series M22T5, "Nonwoven Fabrics."

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